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DEVELOPMENT OF A SELECTION TEST

FOR MOTIVATIONAL APTITUDE

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and J. S. Gottlieb

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Abstract

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This study is the first stage in the development of a test for motivational aptitude. It is based on the hypothesis that the aptitude for acquiring the social motives ranges widely in the population from the lowest in schizophrenia and the hobo type to the highest in the most productive people. The criterion groups first examined are successful college students and professional people contrasted to chronic schizophrenic patients and skid row habitues. All motives are largely mediated through the physiological systems controlled by the autonomic nervous system. The procedure used therefore is the acquisition of a conditioned (learned) response of the autonomic nervous system; namely, the classical conditioning of the palmar sweating response (GSR). Results on 19 control subjects and 28 schizophrenic patients and a skid row habitue showed the patients and skid row subject to be essentially lacking in the ability to learn the association between the tone (CS) and the pain stimulus (UCS) by producing a GSR to the tone after some 30 training trials. In contrast, the healthy group made this association readily as revealed by the frequency, consistent latency and amplitude of GSR responses to the tone alone.

Conclusions are that Physiologic Learning Aptitude (PLA) which is believed to be a measure of the ability to acquire the secondary or social motives can be measured by this conditioning procedure. With further documentation and streamlining, this procedure should have a valuable application for the selection of highly adaptable persons who can be readily trained or conditioned for high-stress tasks such as space flight.

author

DEVELOPMENT OF A SELECTION TEST FOR MOTIVATIONAL APTITUDE[1]

A. F. Ax, P. G. S. Beckett, N. A. Fretz,
and J. S. Gottlieb*

A very important aptitude or capacity of any individual for successful accomplishment is his motivation at the time of the performance. Social or secondary motives such as desire for the approval of our fellows, the desire for money, or self-determined goals are learned motives. The motivation which actually drives and guides behavior is a physiological state of arousal which involves mainly the autonomic nervous system controlled organs and physiologic processes. Thus the learning or adaptation of motives is largely the learning of the autonomic nervous system. This type of physiological learning which is more often called <u>adaptation</u> is quite different from the usual type of intellectual learning of school subjects, the capacity for which is called intelligence or I.Q. This physiological learning is a training of the emotions so that the resources of the body, which involves the maintenance of homeostasis within acceptable ranges, may be fully utilized for the task at hand. When the task is quite difficult for the person, the motivational limits are often exceeded long before the body's resources would be exhausted, but the individual of low or moderate motivation gives up and cannot complete the task. With better training of the motives, this same individual, on another occasion, may be able to complete the task. Involved in this motivational training of course, is physical training which "conditions" the person to be better able to perform rigorous tasks. The motivational conditioning and the physical conditioning are not completely independent nor are they one and the same. A soldier can be in perfect physical training but still not have the "stomach" for battle; on the other hand the soldier who has the will to fight is that much better able to carry it out if he is in good physical training.

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The "stomach to fight" is the emotional or autonomic nervous system physiology involved in the emotional learning or adaptation which is the problem under study.

Whereas the aptitude or capacity for intellectual learning (I.Q.) has been long studied in detail with reliable quantitative tests, the aptitude or capacity for motivation learning or adaptation has not been so well studied. Yet there is every reason to believe that the aptitude for learning motives varies over a wide range as does I.Q., physical prowess or musical talent. The lack of a test for the aptitude for learning motives handicaps us in selecting personnel for high-stress tasks which involve the extremes of motivation. The problem for selecting persons with the desired skills and the capacity to "take it" for space flight will soon become critical. The need has always been present for personnel selection for military and other high-stress tasks.

In this study we are undertaking to develop a practicable test for motivational, emotional or physiological learning aptitude. Since we believe the aptitude involves many of the physiological systems some of which may not directly involve emotion or motivation we prefer to call it Physiological Learning Aptitude or PLA for short. The test must involve physiological response systems under control of the autonomic nervous system such as the palmar sweating response (GSR) or some parameters of the cardiovascular system such as finger plethysmogram, heart rate or blood pressure. Secondly the test must be a learning task which involves this response system. The classical or Pavlovian conditioning situation provides just such a task. A non-relevant, innocuous stimulus such as a tone is sounded just before and during a relevant noxious pain stimulus which elicits the desired response, for our study, the galvanic skin response (GSR) of palmar sweating. Prior to the pairing of the tone and pain, the tone elicits little or no response, but to the extent conditioning takes place after a series of pairings, the tone, during test trials when not accompanied by the pain stimulus, will alone elicit the GSR formerly produced only by the pain. The various parameters of conditioning such as acquisition rates of the number, amplitude and latency of conditioned responses as well as their resistance to extinction will constitute the measures of Physiologic Learning Aptitude (PLA).

In order to quickly validate whether indeed such a test will distinguish between persons who by their life history are clearly different in social performance we chose two very different groups -- college students and professional personnel contrasted to chronic schizophrenic patients under intensive study at The Lafayette Clinic and chronically unemployed "skid row" characters.

Although the cause of schizophrenia is not yet known, the characteristics of the patients have been well described. The characteristic most relevant to this study is their inability to acquire (or if once acquired to maintain) the social motives such as the desire for social approval, money, responsibility and competence. At the same time their primary biological drives for food, water and comfort are intact.

A corolary of the lack of normal emotional and motivational response patterns in the schizophrenic is the well documented (11,14) lack of empathy for the motives and feelings of other people as well as the equal difficulty that normal people have to empathize with the schizophrenic patient. Empathy is apparently a fundamental part of learning the normal emotions and motives of a culture.

A person deficient in this learning ability but with intact biological drives will quickly come into conflict with society since he would not conform by striving for the socially-approved goals. Society tends to withhold even the primary rewards from those who do not conform. Intense frustration, anxiety and hostility develops along with bewilderment and confusion. Several modes of adjustment are possible to one with such a deficiency: (1) One may withdraw from society such as becoming a hermit or tramp; (2) make direct demands for primary satisfaction which usually precipitates hospitalization; (3) develop delusions and hallucinations in an attempt to rationalize and reduce the anxiety, anger and frustration. Emphasis of the first behavior mode only is likely to produce a hobo, tramp or "skid-row" habitue. All three types of behavior are usually found in the schizophrenic at one time or another.

When this study was begun in 1962, there were very few reports in English describing autonomic conditioning in schizophrenic patients. Two studies (15,20) are reported by Mednick (16) to have found increased conditioning of GSR by schizophrenic patients. One study by Peters and Murphree (19) reports significantly less conditioning of GSR in schizophrenia. Late in 1963, the report by Lynn (13) of the recent Russian literature was published which revealed rather extensive studies of conditioning in schizophrenia. The consensus of these studies is that conditioning of both motor and autonomic responses is grossly deficient by all parameters of conditioning (amplitude, frequency, latency and number of trials required). The Russian authors generally interpret their findings by the Pavlovian theory of schizophrenia (18) which is based on the theory of protective inhibition. Schizophrenic patients are said to have an overly sensitive "weak" nervous system which is prone to protective inhibition thus limiting adjustment to a narrow range of environment.

This deficiency in aptitude for learning social motivation or Physiological Learning Aptitude -- PLA as we shall call it -- should manifest itself in deficient conditioning of GSR to the tone-pain conditioning pardigm. This hypothesis which predicts an impairment in conditioning for schizophrenia is directly opposite to that proposed by Mednick (16) which predicts an increase of conditioning aptitude for schizophrenic patients.

Just as there are often various physical abnormalities accompanying the severest forms of intellectual deficiency, it is reasonable to suppose there might be various physiological or biochemical abnormalities which may accompany the physiological learning deficiency. The failure for certain enzymes to develop as postulated by Frohman et al (6) which could result in the excessive concentration of a natural stress product to toxic levels could be an accompaniment for some schizophrenic patients. Many physiological abnormalities have been reported in schizophrenia but none have been uniformly present. The relative strengths of such abnormalities in addition to the general deficiency in secondary motivation could account for the great heterogeneity in schizophrenia which may actually constitute several varieties in terms of sumptom pattern, etiology and treatment required.

The first step in examining this hypothesis is to compare a typical sample of schizophrenic patients with a normal sample on a learning task involving the autonomic nervous system. The classical conditioning study described below, we believe fulfills this first step. The highly favorable results obtained in this study support further examination of the hypothesis by studies of other groups who might be expected to show a deficiency in physiologic learning aptitude and secondary motivation. These may include various types whose behavior seem to indicate deficient social motivation such as the chronic unemployed hobo and skid row habitue. In order to investigate further whether deficient PLA may be a necessary but not sufficient etiological condition of schizophrenia, it would be valuable to examine for PLA the relatives of schizophrenic patients, especially their children.

Future studies and the application of this concept of physiological learning aptitude is not limited to frank mental disorder. As with intellectual ability, it may be assumed that the ability ranges throughout the population from very low in the hobo or schizophrenic or to very high in the highly driven successful person. PLA should be highly predictive of success in any task where motivation plays a major role. It should be very useful for selecting persons for specialized high-stress tasks where exceptional motivation is needed. High PLA should also imply a high degree of physiological adaptability for successful adjustment to severe stress -- thus may constitute a measure of stress tolerance.

By knowing the PLA of children, it should be possible to devise training programs more appropriate for optimum development of their motivational system. Because of the heterogeneous environmental opportunities for motivational conditioning American children experience, it is unlikely that PLA can be estimated, like I.Q., by current accomplishment. Rather actual learning tasks such as conditioning studies of autonomic processes will have to be used.

Procedure

Method

Our experimental procedure of classical conditioning, which we consider a measure of PLA, is carried out over four sessions on successive days during which continuous recording is done on 14 physiological variables. On the first or adaptation day three different pitched, interrupted tones (CS) (T_0 = 470 CPS, T_1 = 770 CPS, T_2 = 1240 CPS and about 60 db) are each presented for 12 seconds, five times in a fixed modified random order at intervals ranging from 2 to 2.5 minutes. In the second and third or conditioning sessions, the two higher pitched tones T_1 and T_2 are reinforced during the last six seconds by the two pain stimuli (UCS) S_1 and S_2 respectively presented to the pads of the great and adjacent toes. The pain stimulus is a DC current (S_1 = 2.5 and S_2 = 3.5 M.A.) applied by sponges saturated in $Zn\ SO_4$ in a plastic cup about 7 mm in diameter (40 sq. mm) and about 6 mm deep with a zinc disk at the bottom. In the fourth or extinction session the tones only are presented as on the first day.

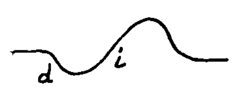
The subjects were instructed for the adaptation session that they would hear some tones but there was nothing they need do about them. For the two conditioning sessions they were told that today some of the tones would be accompanied by a brief pain in their toes which would feel like heat. For the extinction session they were told that today there would be no pain stimuli. The pain electrodes were not applied for the adaptation and extinction sessions. This information was given to the subject in the hope that it would eliminate one source of random variance based on varying hypotheses by the subjects as to when they might be given pain stimuli. We are more interested in investigating the unconscious and involuntary aspects of autonomic response than the conscious expectations.

Subjects

The control subjects, all male, were hired from university and city employment agencies. They were interviewed by a psychiatrist and rated on the standard Lafayette Clinic Psychiatric Rating Scale (4). In addition, they were given the following psychological tests: (a) Minnesota Multiphasic Personality Inventory, (b) Wonderlick Personnel Test, (c) Reversed Digits, (d) Weight Discrimination and (e) Auditory Discrimination. These tests are part of a basic test battery given to the schizophrenic patients by the Psychology Service. If any control subject was judged to be unhealthy by the psychiatrist he was either not tested or placed in a special third group. The age range for the control group was 19 to 44 with a mean age of 28.1 years. The schizophrenic patients, all male with an age range of 27 to 41 and a mean age of 31.4 years, constitute a special group with a mean duration of illness of 7.6 years and with a minimum of over two years. Since the correlation of our major conditioning score with age for the control group was essentially zero (.01), this slight difference in age between the control and schizophrenic groups is irrelevant. The schizophrenics are kept on a special research ward and had been off drugs for a year or more and are under intensive study by the Clinic. These patients are required to participate in a daily program of exercise. All the patients have had the same psychiatric ratings and psychological tests as did the control subjects.

The schizophrenic patients have been classified by Dr. Frohman on the basis of the lactate piruvate ratio (L/P) as described in his reports (7,8) into 3 groups. Group I contain only patients whose stress L/P is greater than 10.0. Group II are those who vary a great deal in L/P producing a mean basal L/P less than 8.5 and a stress L/P greater than 11.0. Group III are those whose basal L/P is less than 8.5 and stress L/P less than 11.0 which are characteristic values for non-schizophrenic subjects. Our conditioning scores are compared on the 3 schizophrenic groups and on the healthy control group.

Two variables, skin conductance (GSR) and skin potential (SP), have been analyzed by taking measurements from the polygram. The skin conductance, whose changes are called galvanic skin responses (GSR), is measured by passing a small current ($<$ 14 microamperes) through the volar surfaces of the 2nd and 3rd fingers near the tips via two sponge electrodes. Each electrode consists of a circular zinc disk placed in the bottom of a plastic cup about 6 mm deep. A sponge, slightly larger than the cup volume is saturated with a 1/10 normal zinc sulphate solution and compressed into the electrode cup as the electrode is applied to the finger with adhesive tape. Electrode polarization drift is prevented by continuous reversing of the potential twice per second. This system has been previously described (2). The skin potentials are measured by non-polarizable silver-silver chloride electrodes (17) placed on the little finger tip and forearm with Sanborn "Redux" electrode paste. The potentials are fed into an Offner electrometer coupler model 9808A with an input impedance greater than 1000 megohms. Frequent calibration prevented serious drift. The responses to the tones during adaptation and extinction are measured over the entire 12-second period of the tone. During the conditioning series, the CR was measured only during the 6-second period of the tone before the pain began. The UCR was measured during the 6 seconds of the pain. All skin conductance changes to the stimuli are increments in conductance and called GSRs. Skin potentials are of four types, hence each type must be scored separately. The four types are:

1. Negative biphasic 

in which the values scored are the decrement (d) and the increment (i). A typical negative biphasic response might be a base level of -20 millivolts, (the finger tip is usually negative with respect to the indifferent point on the forearm) with a decrement of -5m.v. to -25m.v. followed by an increment of +10m.v. to -15m.v.

2. Negative uniphasic 

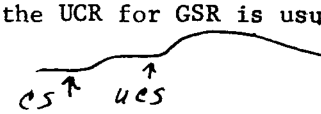
, decrements only.

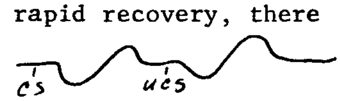
3. Positive biphasic 

, increments and decrements scored separately.

4. Positive uniphasic 

, increments only.

During the conditioning session, the UCR for GSR is usually a further change on top of the CR 

But for skin potential which has a more rapid recovery, there may often be two responses as follows: 

These differences in type and recovery time between GSR and SP necessitates different treatment in analysis. For GSR, the score is simply the first increment measured from its beginning rise to its maximum or to the level reached during the stimulus period. For skin potential, the increments and decrements (whether from uniphasic or biphasic responses) are treated separately as different scores. It has been suggested by Wilcott (21) that the direction of SP response is a function of base level at the time of the response. This relationship of the size of response to the base level has been named the "Law of Initial Values" (LIV) by Wilder (22) and a series of articles has been reported on how best to adjust the response data for base levels (5,9,12). Some variables under certain circumstances such as heart rate in infants as reported by Bridger and Reiser (6) do seem to obey the LIV so that with high base levels the responses are small or negative. The LIV is supposed to be a manifestation of homeostatic restraining forces increasing with increased deviation, thus making further increases at very high levels increasingly improbable. However, with GSR, at least when reported in conductance units, the relationship appears to be reversed; namely, that larger positive responses are associated with higher base levels (10). In our group of healthy subjects, we also found a positive correlation of .26 between base level and GSR amplitude. When we inspected skin potential for relationship between response amplitude and base level, we found no consistent trend. For a control subject, the correlations were essentially zero. In a patient for one stimulus a correlation between base level and increment was .57 but for the other two stimuli it was zero. For decrements the correlations ranged from .09 to .77. Plots of these data showed no consistent trends.

At least for GSR some principle other than LIV seems to be operating. Individual Response Specificity (IRS) immediately comes to mind. If an individual is above average in GSR responsivity, during the moderate stress of the psychophysiological procedure he would be expected to assume above average skin conductance level and to respond to stimuli with above average GSRs, thus producing a positive correlation between base level and increments contrary to the LIV. By considering the problem within one individual responding to repeated stimuli, individual response specificity is by-passed and one would expect to see LIV in operation. One healthy control subject and one schizophrenic patient from Group III were inspected for LIV operation for GSR and SP from this present study. To our surprise for each subject on 60 stimuli, the correlations between base level and GSR were .74 for the control and .31 for the patient, both correlations being positive and contrary to the LIV. It would appear that one must invoke still another principle. Possibly with higher states of "arousal" the sweating level is higher and also larger responses are made.

When one considers the probability that the size of a response is a function of the level of other physiologic variables as well as its own base level, plus the influence of individual response specificity and level of arousal all confounding the tenuous operation of LIV, any procedure for correcting the response amplitude becomes very questionable, hence we concluded that, at present there is no rational method for correcting increments in terms of base level and hence we are not attempting to correct our response scores until more analysis has clarified how a correction for base levels can be usefully made. Another type of correction for the conditioned response based on the size of the unconditioned response is used, however, and is explained in the results.

Results

An important consideration for classical conditioning is to be assured that the unconditioned stimulus is indeed eliciting an unconditioned response. Figures 1 and 2 give this information for GSR. Figure 1 shows the frequencies of responses for each group. Only schizophrenic Group II show a reduced response frequency and it is still quite adequate for conditioning being 60% and 87% of the normal frequency respectively for the unconditioned pain stimuli S_1 and S_2. In Figure 2 the amplitudes of GSR to the UCS are shown. Schizophrenic Group I give a little larger unconditioned responses than normal while Groups II and III give significantly smaller responses. Group II response mean being just half that for normals and Group III mean 2/3 as large as normal.

Figures 3 and 4 show the same information for skin potential. Groups II and III are slightly reduced in frequency (16% and 15%). Either an increment or a decrement was considered a response. For amplitude of SP response the increments and decrements must be considered separately. In Figure 4 on the left, the increments are shown. Group II is slightly below normal (8%) for increments while Group III is only 1/2 as large as normal for both increments and decrements. With these substantial response frequencies but reduced amplitudes for some groups, we can expect that conditioning could occur but probably with reduced amplitude of response.

In order to compensate for variability in response amplitude, the conditioned response (CR) may be divided by the sum of the CR and the immediately following unconditioned response -- CR/CR+UCR. This ratio of the conditioned response amplitude divided by the sum of the CR+UCR compensates the CR in terms of the "response potential" available at that moment as indicated by the size of the UCR to the immediately-following pain stimulus. Because there were a few cases where the UCR was zero, which would have made the ratio CR/UCR = ∞ , it was necessary to include the CR also in the denominator. Thus the maximum range of CR/CR+UCR is 0 to 1.0. The obtained range for the control group being .134 to .720 and for the schizophrenic groups .000 to .622. Thus, the momentary level of arousal, the individual response specificity and the "law of initial values" however it may be operating, will be properly adjusted for unless, of course, the CR is so large that the base level for the UCR is substantially changed.

An overview of the GSR data may be seen in Figure 5. For each of the four sessions (adaptation, first conditioning, second conditioning and extinction) each of the three tones (T_0, T_1, T_2) are sounded 5 times. The mean GSR response for each group is graphed for each trial. For the adaptation and extinction sessions the period of observation is 12 seconds during which the tone is on; for the two conditioning sessions the period scored is only the first 6 seconds while the tone is on, but before the pain begins. This difference in time period could only make slightly larger the mean response for the adaptation and extinction periods as compared to the conditioning sessions because some of the responses may have continued to rise beyond the shorter 6-second interval. The normal control group, represented by the solid line in the top portion of Figure 5, starts out high at about .67 µmho and quickly drops to less than .10 µmho on the 15th trial. On the first trial of conditioning, there is a marked increase which is an example of the return of an adapted out orienting response. The subsequent reinforced 5 trials show consistent increases which may be considered conditioning. The following 10 trials, however, show an irregular decline in amplitude. An inspection of a similar curve of the UCR also show this decline (Fig. 6). This appears to be an adaptation of the responses to both the pain and tone. At the beginning of the second conditioning session there is a remarkable recovery from the adaptation, but once again during the later trials of the session adaptation appears. On the first trial of extinction this recovery from adaptation does not occur, probably because the subject is told there will be no pain stimuli. During the extinction session, however, there is a further decline which can be called either extinction or further adaptation. The levels of response reached are as low as during the first adaptation period; hence extinction can be said to be complete.

The three curves for the schizophrenic groups deviate markedly from the normal pattern. Group I, the schizophrenic group which have the L/P factor in the blood, is shown in the upper section of the graph as a dotted line. Except for the very first response to the tones, there is no evidence of adaptation. The orienting responses tend to be somewhat larger than those for normals after the first three responses. During the conditioning sessions, there is no tendency for the curve to rise suggesting a complete lack of conditioning, nor does there appear to be any further adaptation during extinction. Essentially the same course is found for schizophrenic group II, who sometimes have the L/P factor. Group III, the dotted curve in the lower section of Figure 5, however, who never have the L/P factor appear to show some conditioning and extinction, although much less than do normals.

A similar course for all groups is seen for SP which is graphed in Figures 7-9. The frequencies of conditioned responses for each session for each group for both

GSR and SP are shown in Figures 10 through 17. These frequencies of CR tend to show the same trends as amplitudes though not quite as clearly.

Probably the best measure of the conditioning is the CR/CR+UCR for GSR shown in Figure 18. Here the means of the trials 3, 4, 5 and 8 for first conditioning and trials 2, 3, 4 and 6 for second conditioning are combined. These particular trials were selected because they are near the beginning of each session before adaptation has progressed. The first trial is not chosen because for the first conditioning session no conditioning has occurred in the first trial and for the second conditioning session the first trial is a T_0. This conditioning score, CR/CR+UCR, is based on 2 T_1 and T_2, the reinforced tones near the beginning for each conditioning session. Clearly all three schizophrenic groups have markedly smaller CR than do the normal control group. Schizophrenic group III has definitely larger CR than does either group I or II. Similar scores for SP seen in Figure 19 show a similar finding.

These differences are all statistically significant both by t tests of the amplitude differences (see Table 1) and by X^2 of the frequencies of occurrence above and below the mean (.45) taken as a cutting point. By inspection of Table 2 we find the control group, there are five who fall below a score of .45 for CR/CR+UCR while all but one of the schizophrenic group I fall below that value, and all of group II and all but 4 of group III do so. By taking a slightly lower cutting point at .40 all of group II and all but 3 of group III are classified correctly, thus reducing the number of misclassified to 4 controls and 4 schizophrenics.

Still another measure of conditioning is the variance of the latencies of the CR. For a 12-second period, the expected variance for a random latency is 12 seconds.* A sample of latencies taken for random 12-second period where no stimuli were given revealed a mean σ^2 of 10.45. The variance in latencies of the first 2 trials for each tone during the extinction period for all subjects are shown in Table 3 together with their F test significancies. These F's and their null probabilities are tested against the expected value for a random variance for a 12-second interval which is 12.0. Thus a small variance such as control No. 1 has (.0524) produces an F ratio 12.0/.0524 of 229.01 which has a null probability of much less than .01. Such a small variance in latency of response indicates a highly consistent response latency indicating a very high probability that these responses are related to the CS and not simply random responses. Only 4 of the normal group fail to show significantly small variances in latency. Three of these 4 are the same individuals who failed to condition by the CR/CR+UCR amplitude test. For the schizophrenic group I, only three showed significantly small variances in latency which were three of the highest scoring on amplitude. For group II, none showed a significant latency. Three of the 4 who failed to have significantly small variances in latency also had small amplitudes. Inspection of scores of the one who had a large mean

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* For a uniform random distribution the σ^2 is a function of the range.

$$\sigma^2 = (\alpha - \beta)^2/12$$

Where α is the lower range and β the upper range.

$$\sigma^2 = (0-12)^2/12 = 12.0 \text{ for a 12-second interval.}$$

amplitude but a nonsignificant large variance in latency showed that his GSR was abnormally large and frequent; thus apparently by chance producing sufficiently large random responses to obtain a significant mean amplitude during the CR scoring period. These results suggest that there is substantial agreement between the two criteria of conditioning but that when they disagree, it appears likely there was no conditioning. This would suggest that the two criteria should both be used. When this is done, the frequencies of classification as conditioned and not conditioned as shown in Table 4 only change slightly. One more control did not condition (making 13 to 5) and one less in group III (making 3 to 9). Due to the possibility of very rapid extinction, it is possible that the use of the extinction period for computing the variance in latencies was not optimum. Accordingly, a similar study of the variances in latency was done for the selected trials of the conditioning sessions.

An inspection of the conditioning sessions for the normal control subjects who failed the latency test during extinction, reveal that they all did indeed have significantly small variance in latency showing conditioning. The variances of the early conditioning scores for conditioning sessions 1 and 2 are posted in Table 5. All the normal control group have significantly small variances in latency for the two conditioning sessions. For schizophrenic group I the number with significantly small variances increased from 3 in the extinction to 5 for the conditioning sessions. For group II none were significant for either session and group III remained at 8 for both extinction and conditioning. Thus there is considerable consistency in variance in latency among sessions. Due to the fact that some subjects, especially schizophrenic patients, tend to produce frequent and large spontaneous GSR by chance and not related to experimental stimuli there may be found sufficient GSR activity during the tone period to produce a substantial score which would make it appear there had been conditioning. By employing in addition the variance in latency criterion, this kind of false conditioning can be eliminated. Thus we conclude that the two criteria, amplitude and variance in latency, when taken together provide the best measure of conditioning. For our study the extinction period gave a slightly more sensitive criterion for the latency measure.

The purpose of having three different pitched tones and two different intensities of pain was to determine how well the different groups were able to differentiate them by their autonomic reactions. We may first consider the size of responses of four intensities of pain presented after the completion of the extinction series. This series of pain stimuli were given after the formal conditioning and extinction sessions were over so as not to interfere with them. They were necessary to establish what kind of response characteristic each subject had to pain stimuli only. The UCR given during the conditioning sessions are contaminated by the preceding tones and any CR that may be in process when the UCS is given. By inspection of Table 6 it is apparent that the control group adjust the amplitude of their response in a proportional manner to the intensities of the stimuli. In contrast the schizophrenic groups do not regulate the size of their response in proportion to the intensity of the stimulus.

The controls show excellent GSR and SP decrement discrimination of the pain intensities whereas the schizophrenic patients do not so discriminate. It is interesting to note that SP increment does not show this clear discrimination for the control group whereas it does for the schizophrenic group I. This suggests that for the schizophrenic group I SP increment is the more characteristic mode of response whereas for controls SP decrement is the characteristic mode. From these results with pain -- GSR differentiation we might expect that only the controls would discriminate between tones by conditioned responses. There was a tendency in this direction. Table 7 shows how the GSR responses to the three tones differ for each group. Only the healthy control group show a tendency for a smaller response to T_0 that to T_1 and T_2.

CONCLUSIONS

These results strongly support our major hypothesis that schizophrenic patients have a marked deficiency in Physiologic Learning Aptitude (PLA). This deficiency is accompanied by a tendency for reduction in orienting response to the non-noxious stimuli of the tones prior to conditioning. Such a reduced responsivity in orienting response together with normal amplitude responses to the noxious stimulus of pain suggests an intact sensory-response system but which is overlaid with an inhibitory system selectively for non-noxious stimuli. This experimental evidence for an inhibitory system quite closely parallels the clinical observations of withdrawal and lack of interest and curiosity in schizophrenic patients. It is unclear whether the lack of interest in irrelevant stimuli is primary, that is, the deficiency in orienting response is the cause of the poor conditioning or whether a deficiency in association permits "irrelevant" stimuli to remain irrelevant even though they should acquire relevance by association as they do for normal people. This could be a positive feedback situation where each tends to support the other. A primary deficiency in association permits many stimuli to remain irrelevant which in turn aids withdrawal which further tends to reduce perception and orienting response to stimuli, permitting even more withdrawal. Delusions and hallucinations as suggested by Arieti (1) may be motivated mental and perceptual distortions in an effort to maintain some sort of internal rationality for the irrational supression of association.

It would be clarifying to determine whether the manifestation of poor classical conditioning of GSR in schizophrenia is an overlay of inhibition generalized to those stimuli (tones) which have no primary significance or whether the deficiency is a primary lack of association ability. A change in conditioning paradigm may be able to determine this question. If an escape or avoidance conditioning situation were arranged so that it is made immediately rewarding to make the association between an irrelevant stimuli like a tone and a relevant one like pain, it may be possible to determine whether the learning ability is simply lacking or whether, with enough immediate incentive, the inhibition can be lifted and the learning aptitude shown to be intact. Our next studies will utilize such an avoidance situation in an attempt to answer this question.

The other most interesting finding was the lack of conditioning shown by the non-schizophrenic subject, the "skid-row" habitue, who has a long history of non-employment but without any symptoms of schizophrenia. Our general hypothesis of PLA would suggest that low levels could be manifested by this type of adjustment. We plan to test more of this type to see if indeed they do represent a very low PLA group. PLA may be an important variable for diagnosing a person's ability to utilize retraining now of so much concern to the federal government. Some unemployed persons may be essentially unemployable because they lack the basic ability to acquire motivation. If unemployed persons could be properly diagnosed for PLA much money and effort could be saved or concentrated on the ones better able to utilize the training.

Finally, it would appear that PLA would be a good measure of ability to absorb training for high-stress tasks where extreme motivation is essential. When the testing procedure has been streamlined and made as sensitive and practicable as possible we plan to apply it to personnel selected for training for high-stress missions to see if it has discriminative power at these relatively high levels.

The recent translations of Russian literature (13) on psychophysiology indicates that they are concentrating a great deal of effort in this direction. With their tradition of Pavlovian conditioning research it is almost certain that they are considerably ahead of us in technique and theory of motivational learning. Our best chance of catching up is to learn their most recent advances and by use of our more sophisticated data processing system to gain the advantage.

By being able to quciklу select the men with optimum ability for learning the special adaptations required for space flight much shorter training periods would be required for optimum performance. When scientists, physicians and other non-pilot types are to be selected it becomes imperative to have a suitable selection test since it will be impracticable to select by the basis of prolonged pilot-like training as has been used up to now for astronaut selection.

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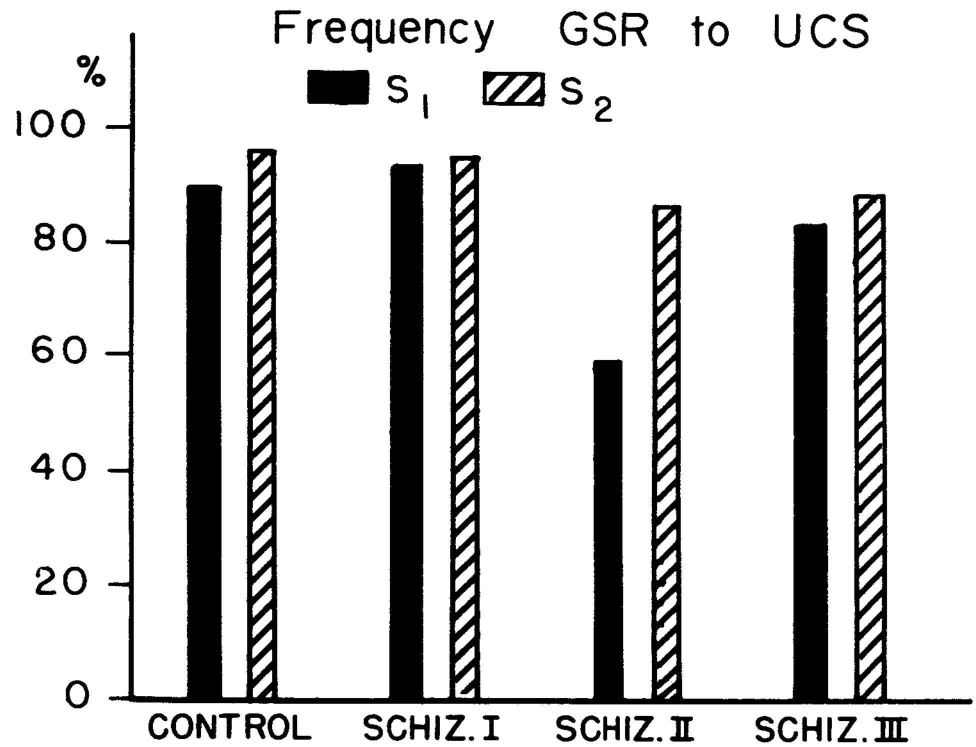
FIGURE 1



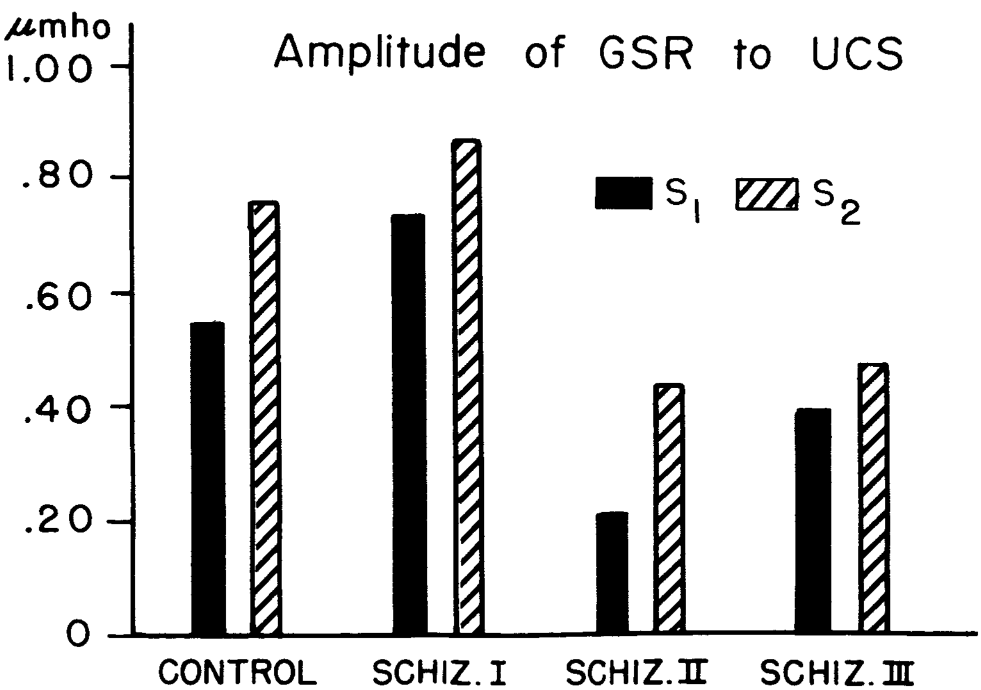
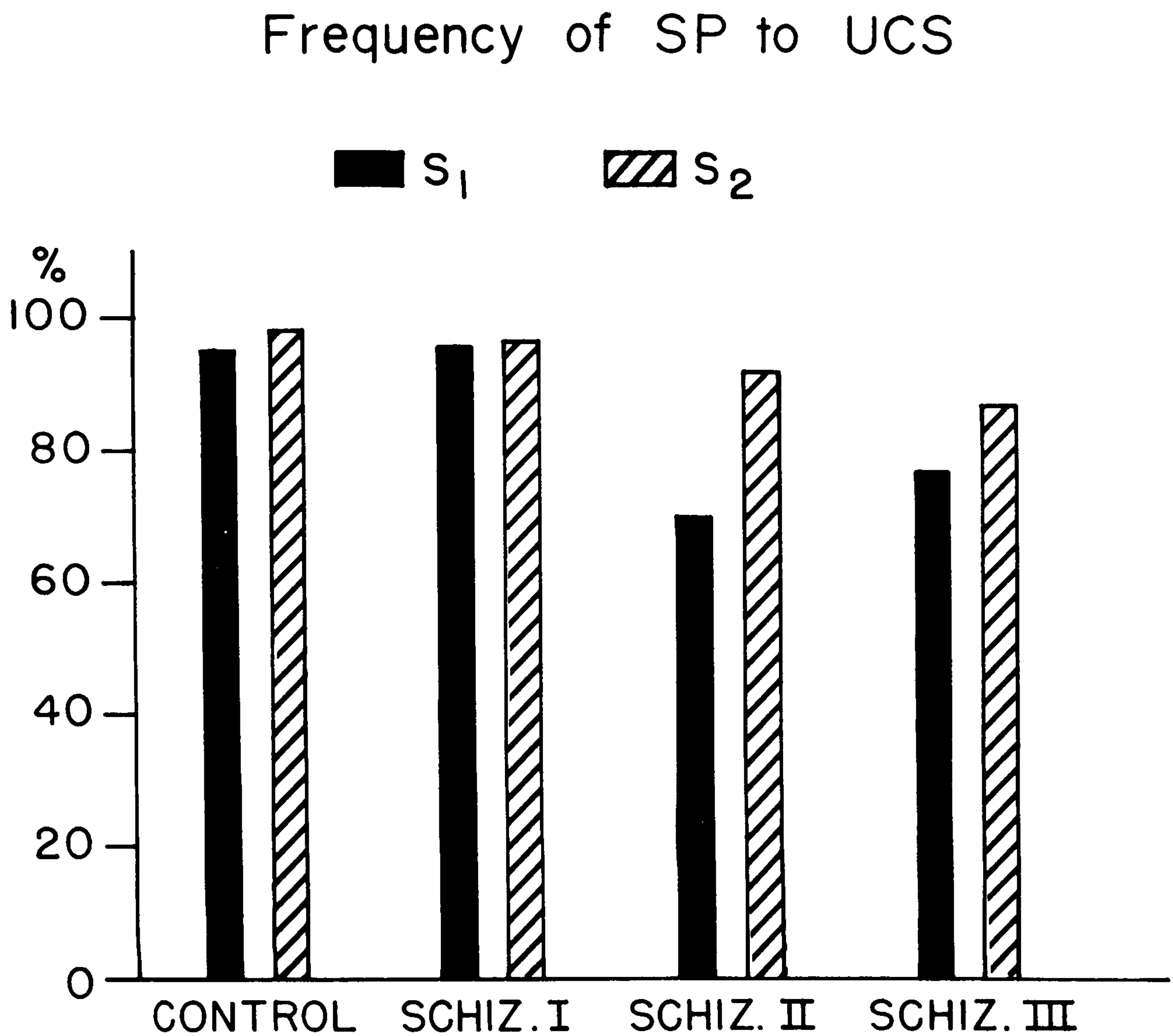


FIGURE 2

FIGURE 3



Frequency of SP to UCS
S1
S2
%
100
80
60
40
20
0
CONTROL
SCHIZ. I
SCHIZ. II
SCHIZ. III

FIGURE 4

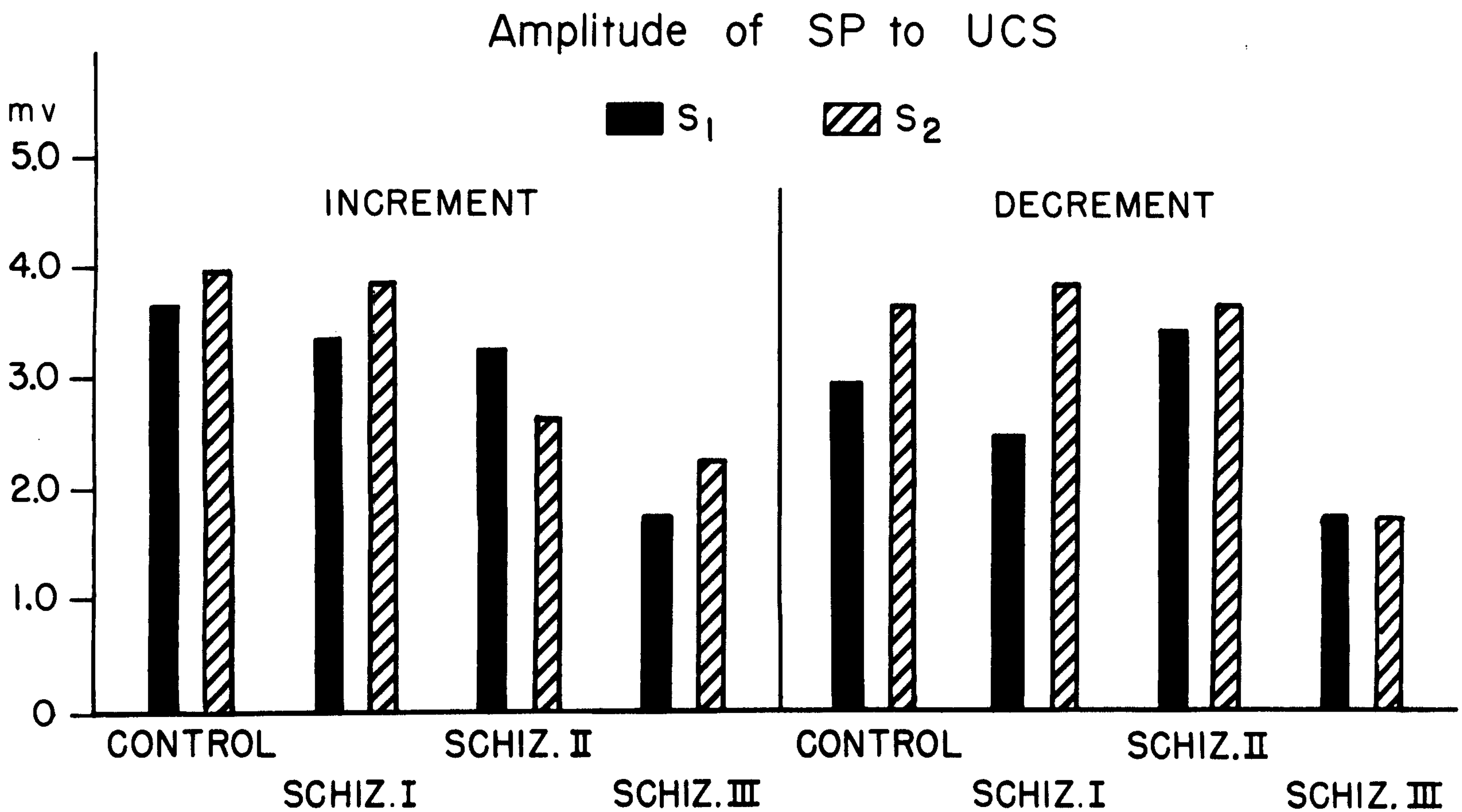

Amplitude of SP to UCS
S_1
S_2
mv
5.0
4.0
3.0
2.0
1.0
0
INCREMENT
DECREMENT
CONTROL
SCHIZ. I
SCHIZ. II
SCHIZ. III
CONTROL
SCHIZ. I
SCHIZ. II
SCHIZ. III

FIGURE 5

SKIN CONDUCTANCE RESPONSE (GSR)
TO CS FOR ALL SESSIONS

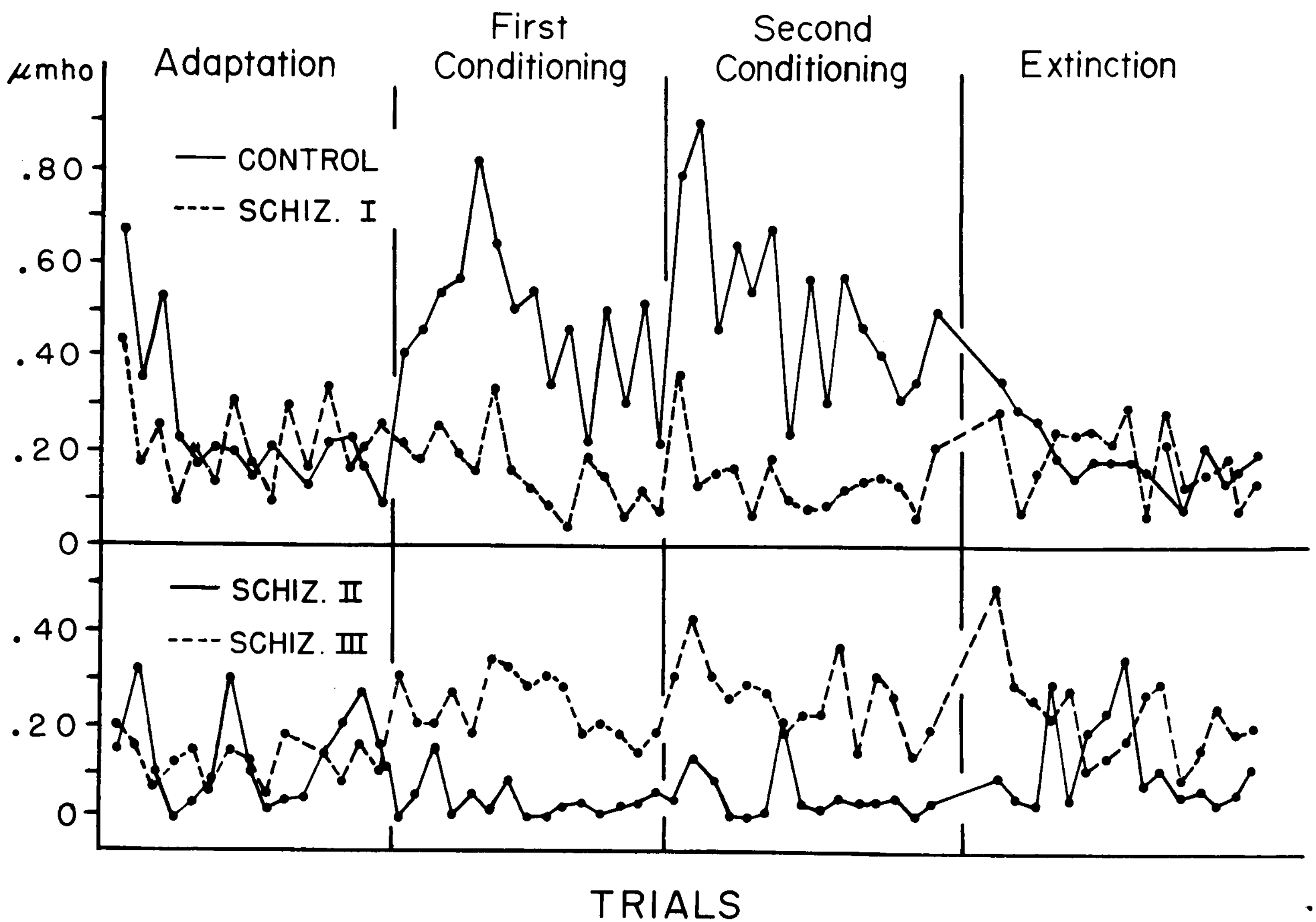
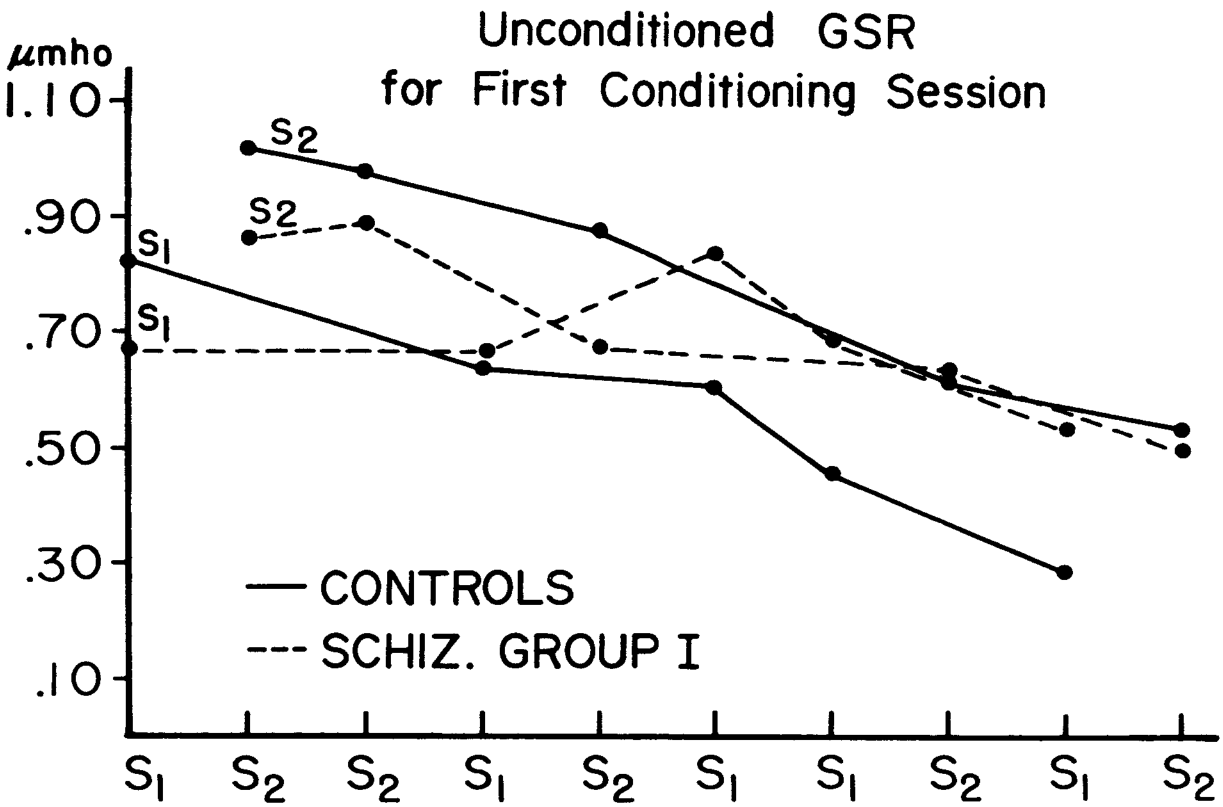
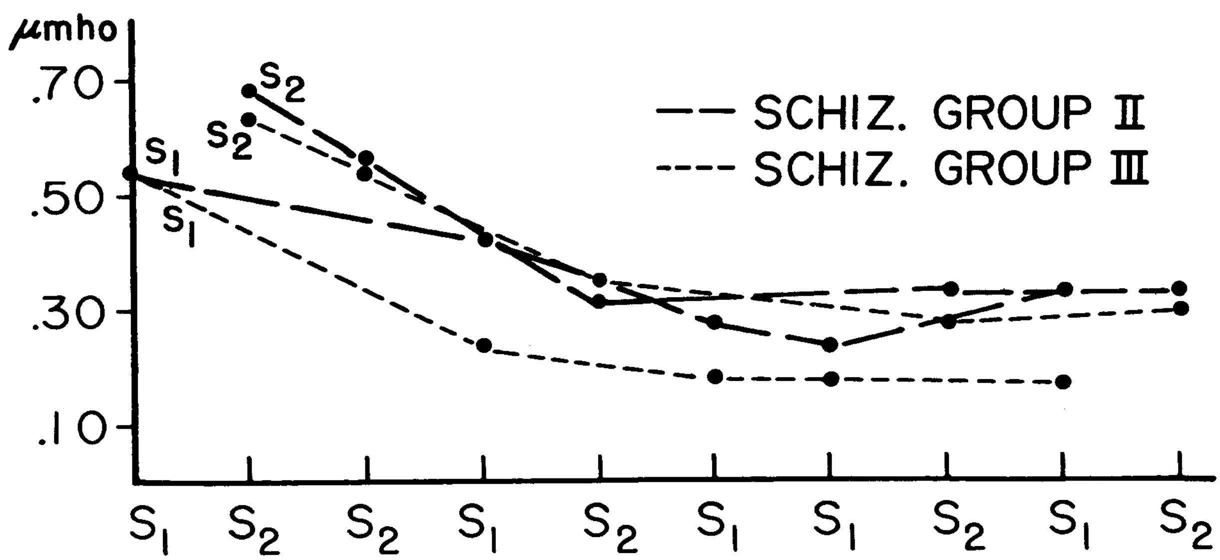


FIGURE 6A

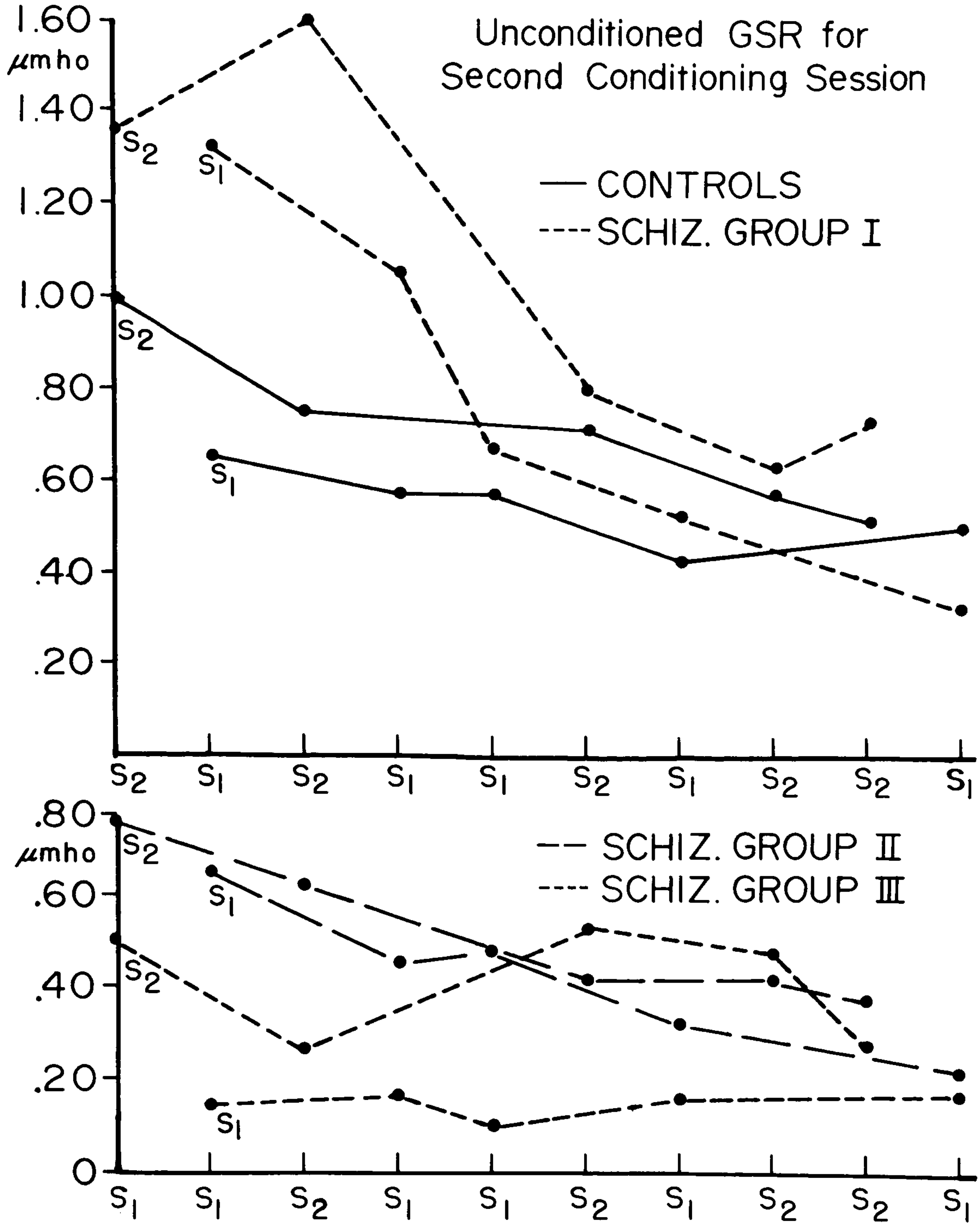


PAIN STIMULI



PAIN STIMULI

FIGURE 6B



PAIN STIMULI

FIGURE 7

SKIN POTENTIAL (INCREMENTS and DECREMENTS) TO CS FOR ALL SESSIONS

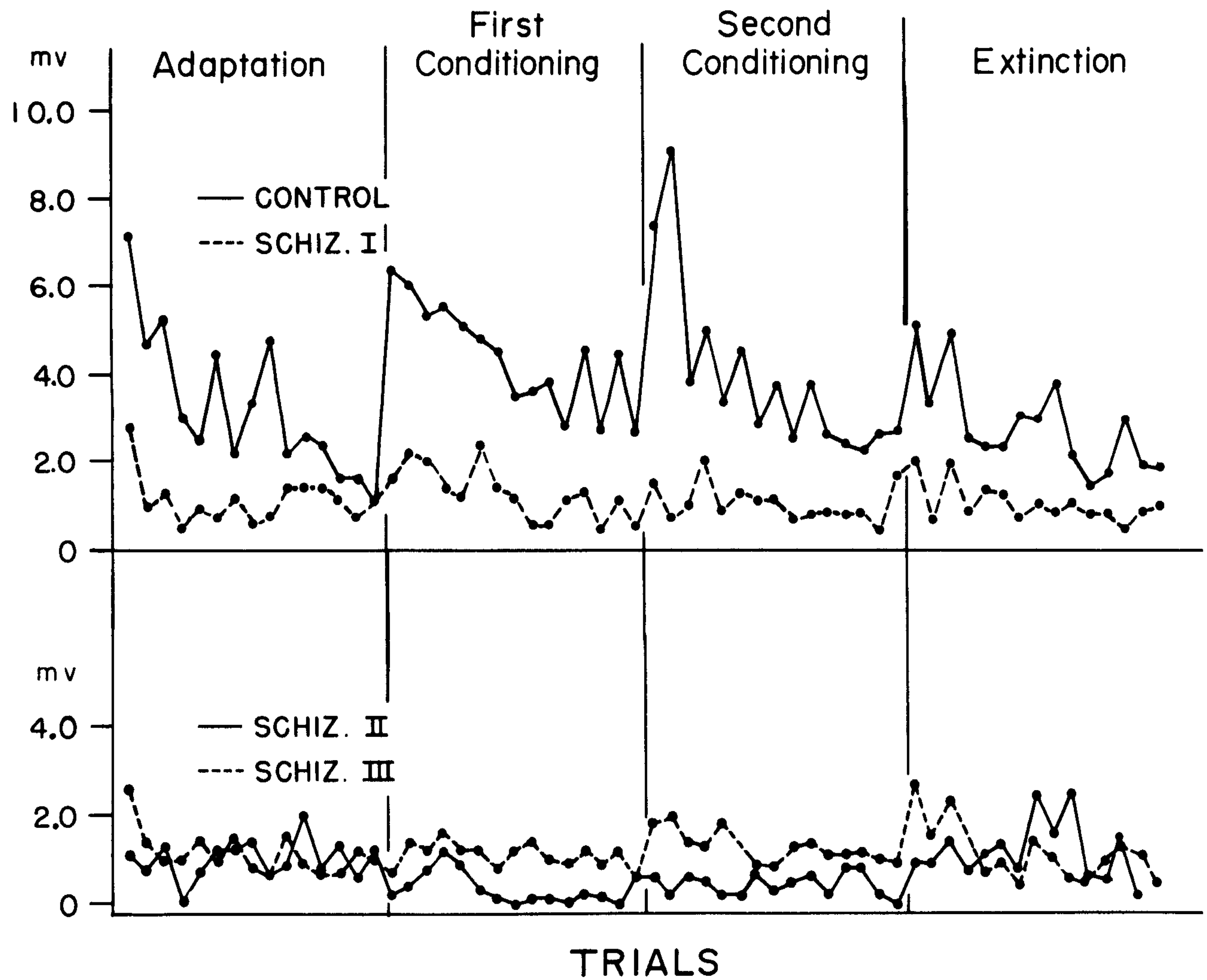


FIGURE 8

SKIN POTENITAL (INCREMENTS) TO CS FOR ALL SESSIONS

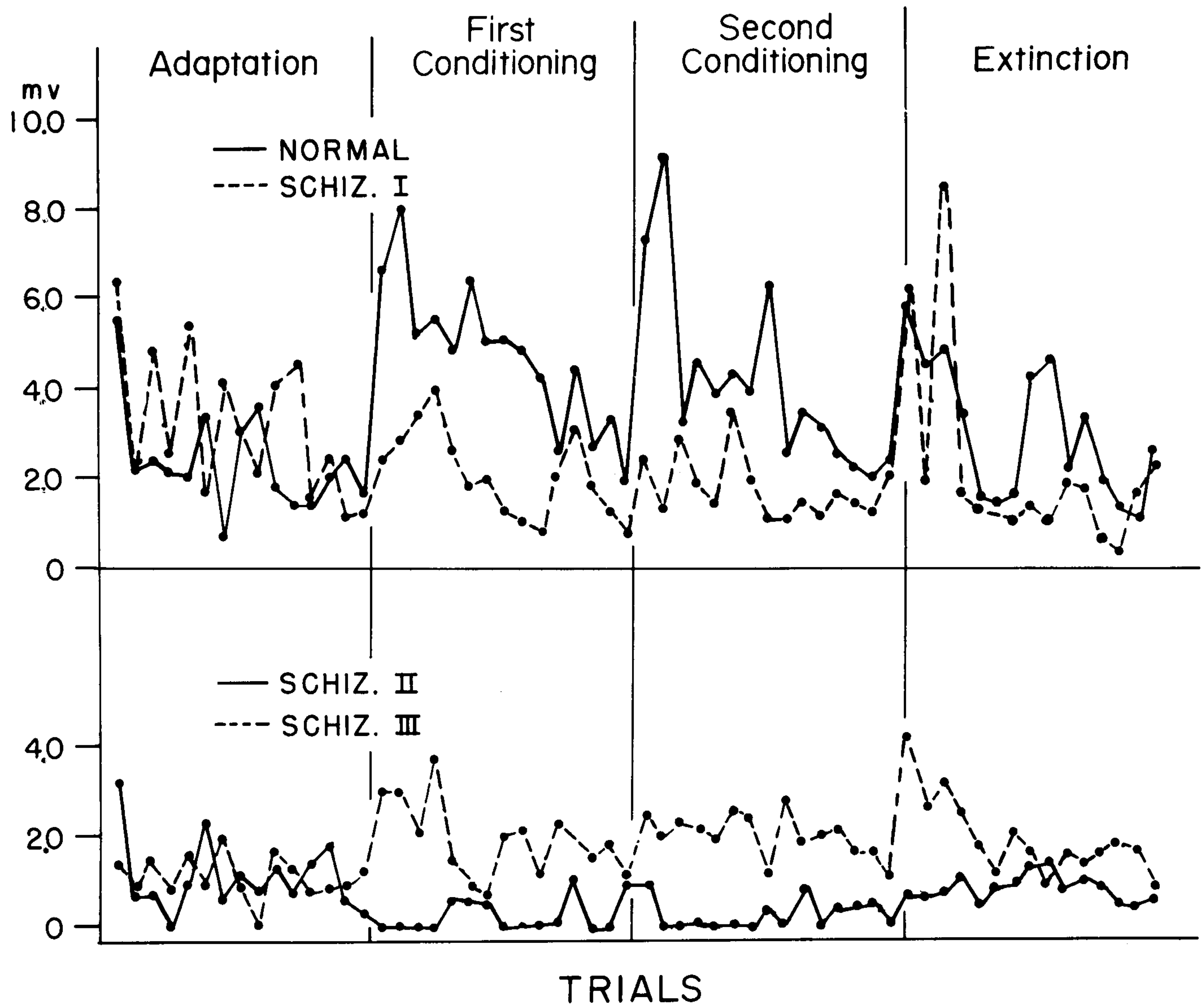


FIGURE 9

SKIN POTENTIAL (DECREMENTS) TO CS FOR ALL SESSIONS.

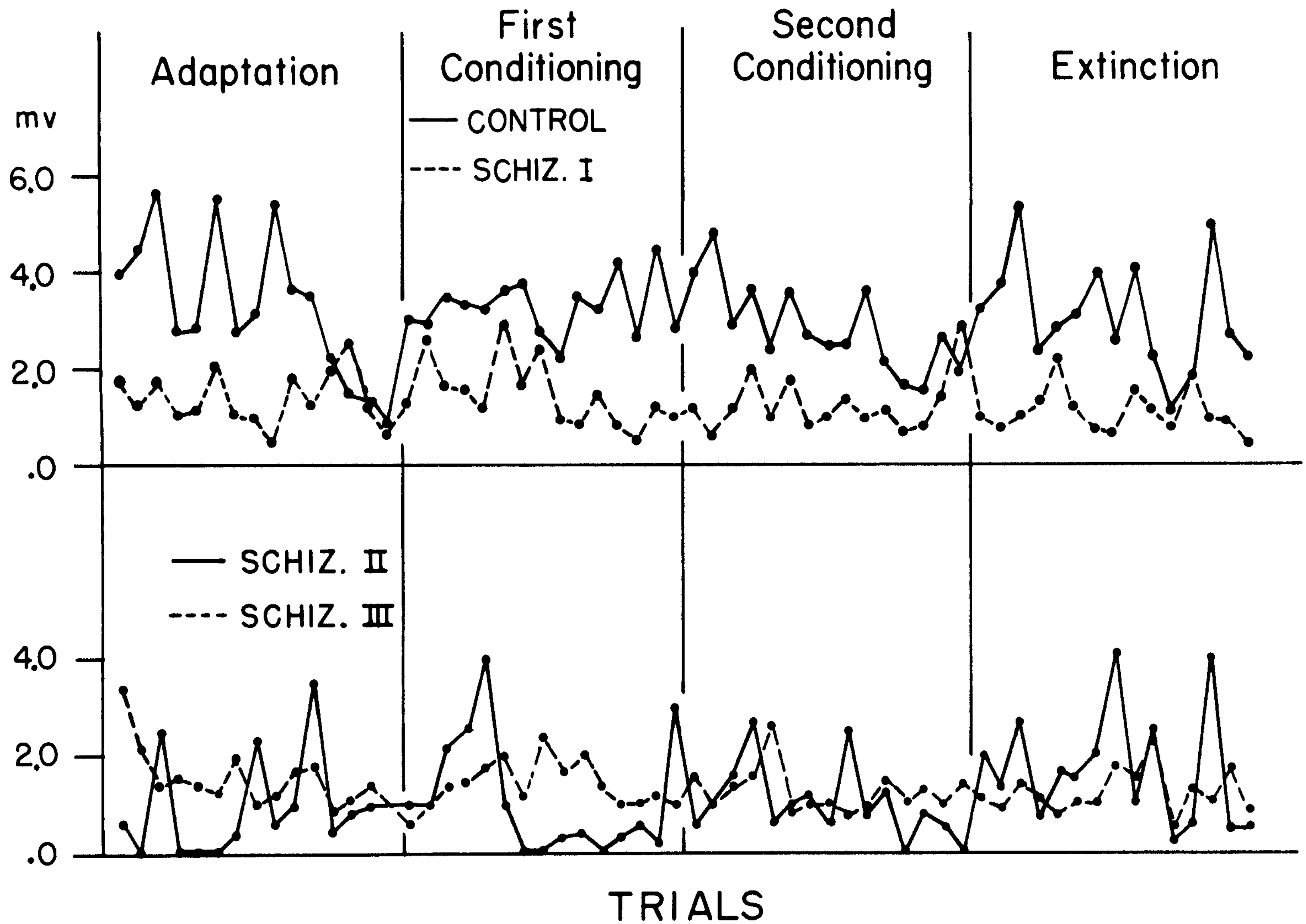
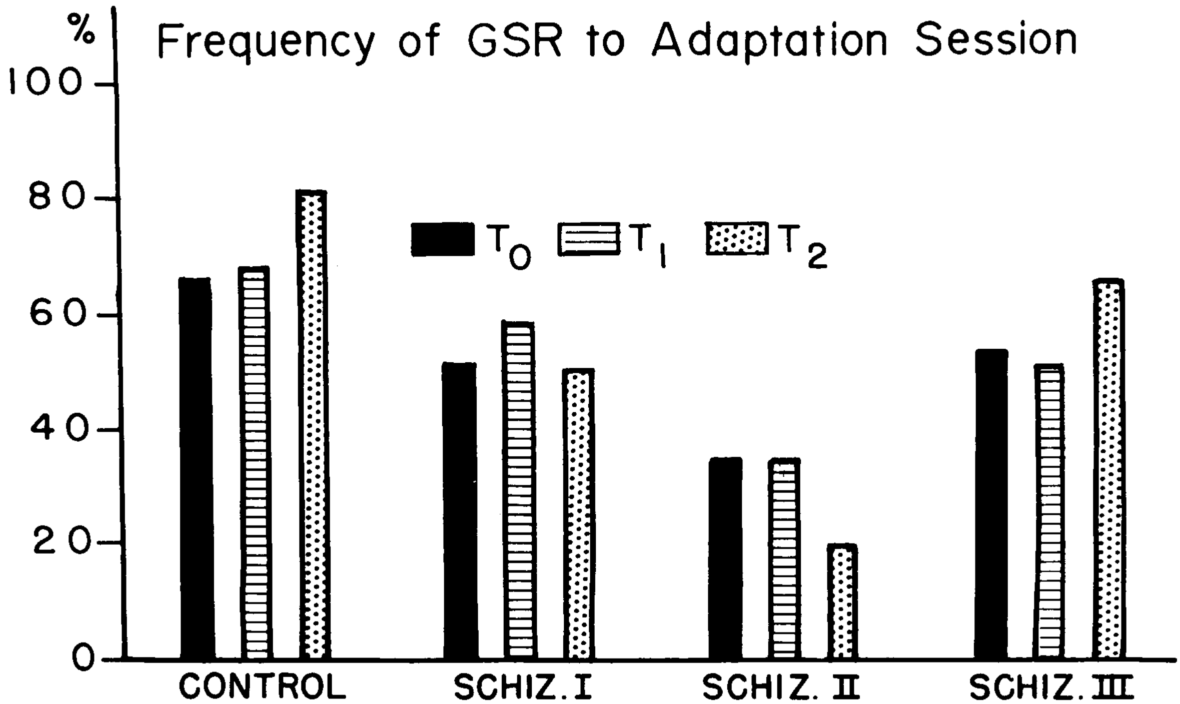


FIGURE 10



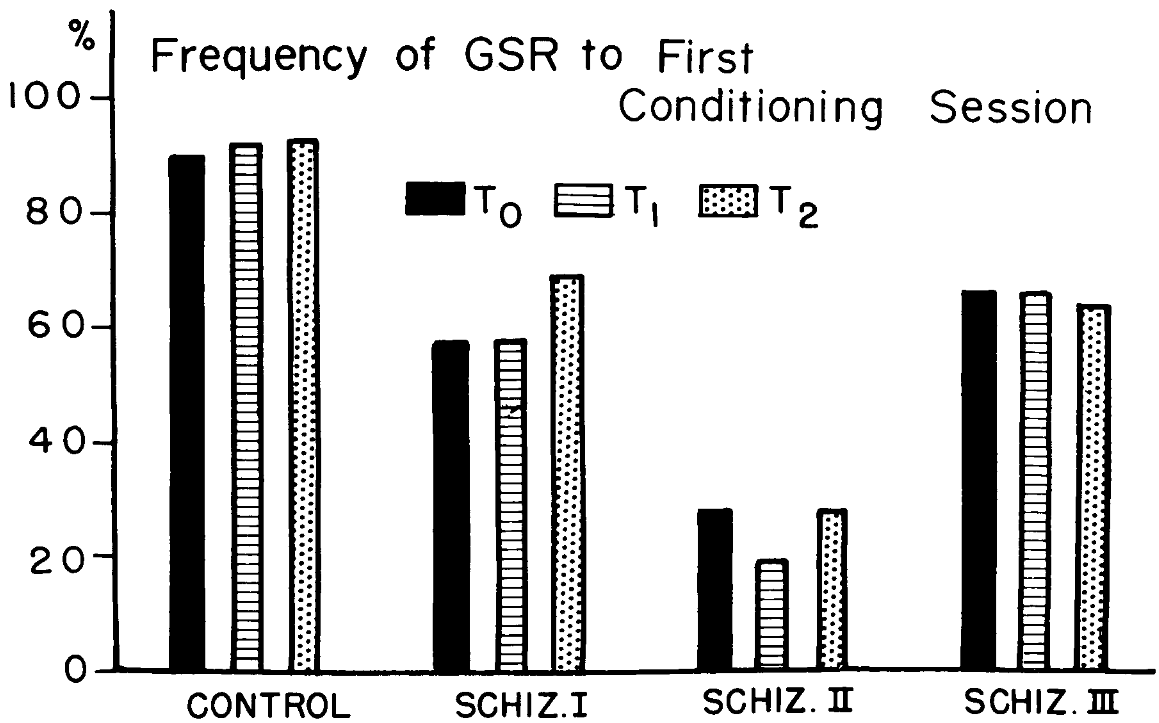
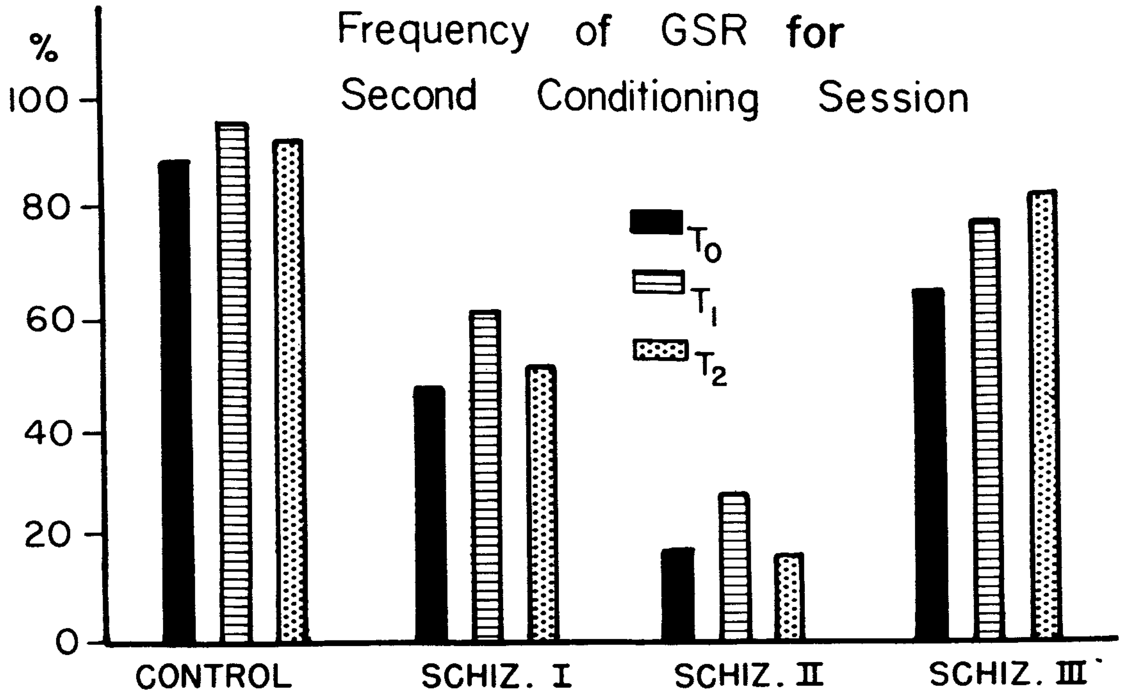


FIGURE 11

FIGURE 12



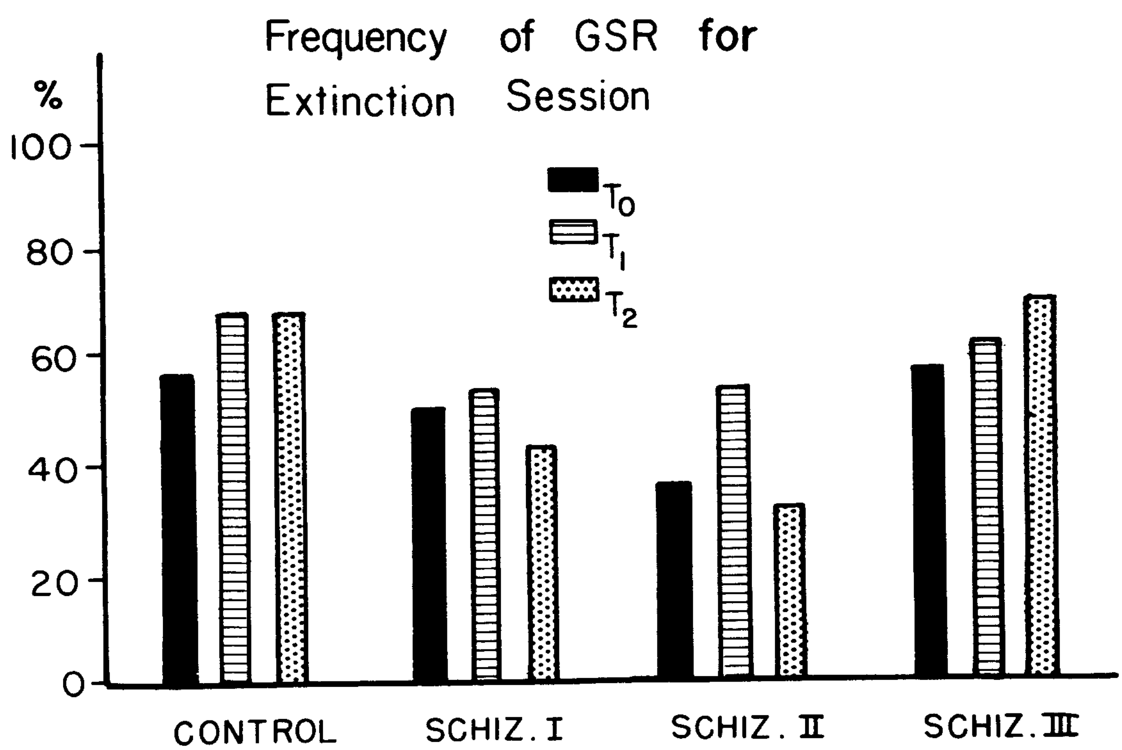
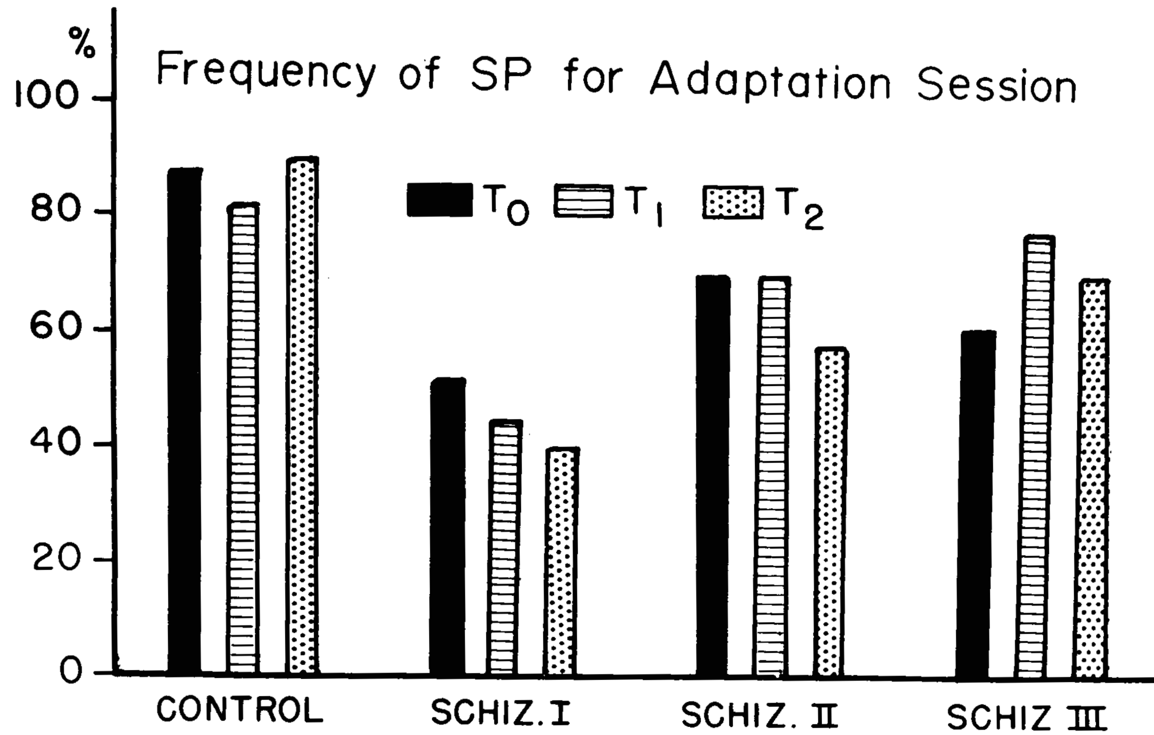


FIGURE 13

FIGURE 14



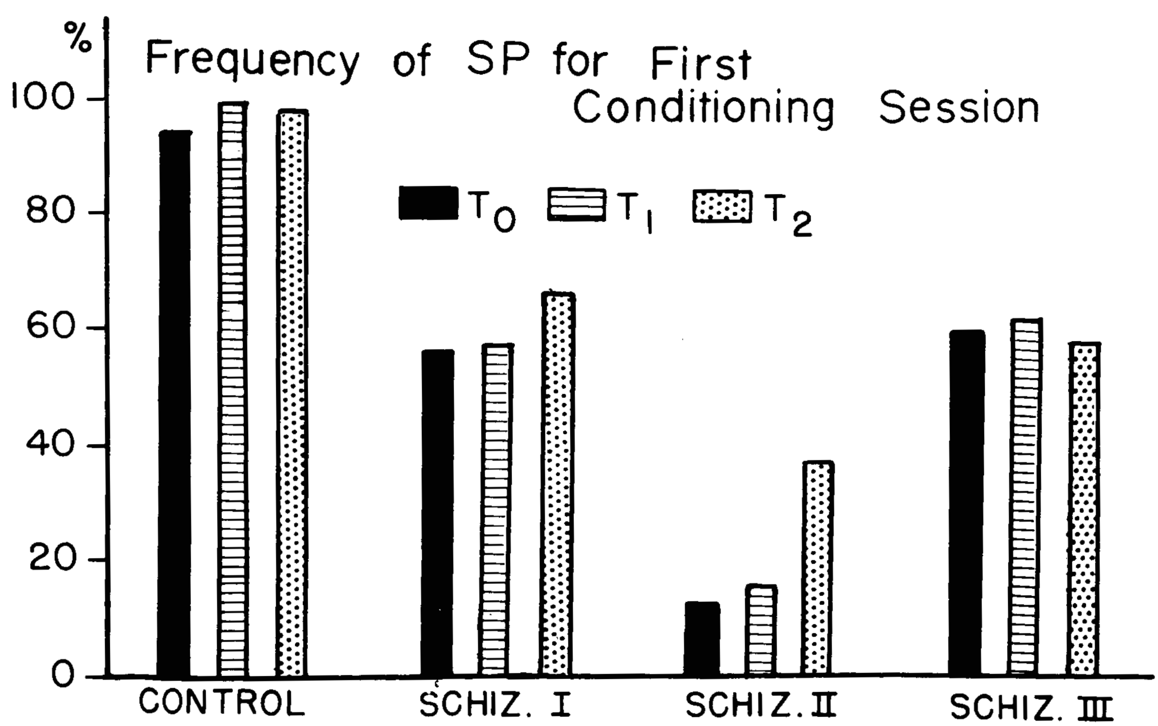
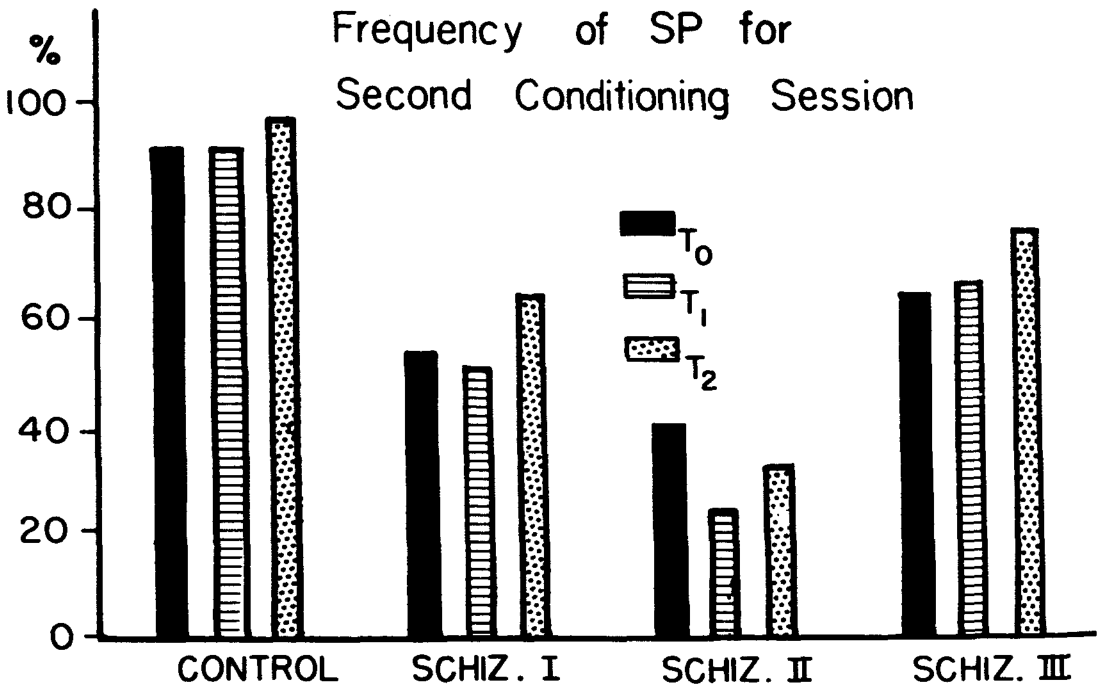


FIGURE 15

FIGURE 16



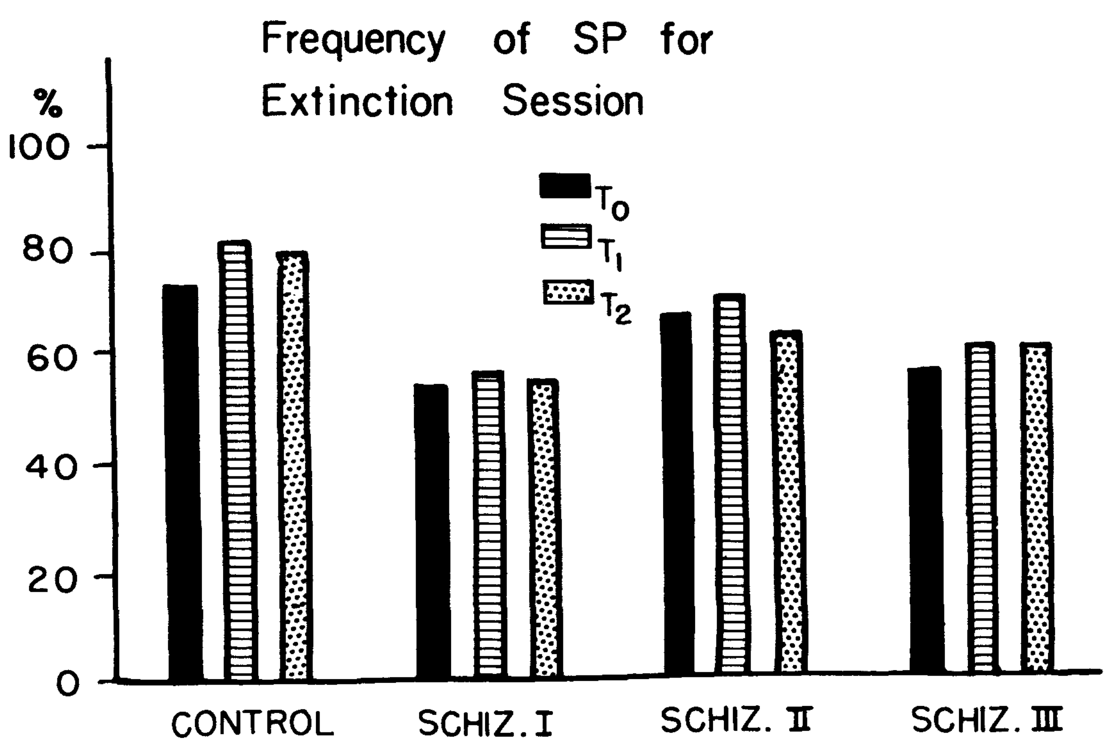
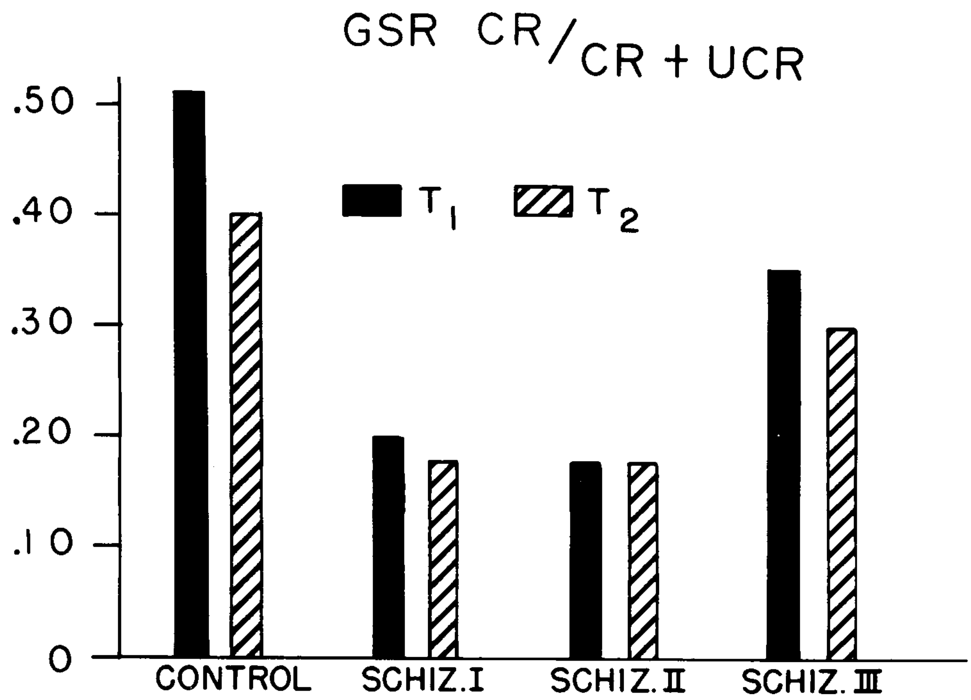


FIGURE 17

FIGURE 18



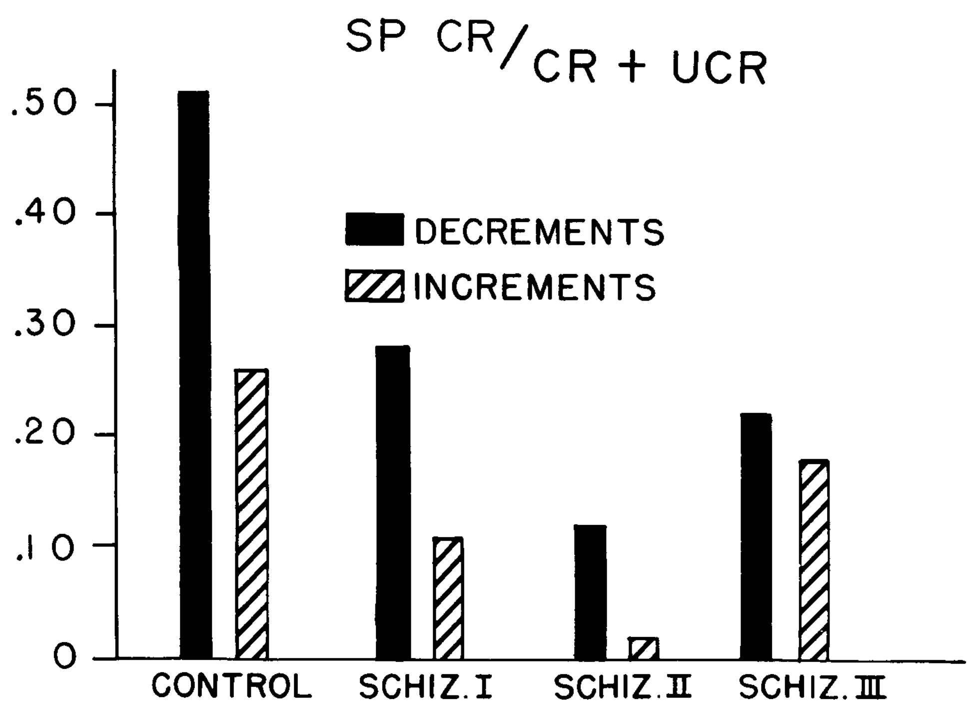


FIGURE 19

Table 1

Mean Differences Between Groups on GSR of CR/CR+UCR for Selected Trials

	Mean	F	t	Prob.
Control	.454	1.22	4.28	.01
Schiz. I	.189			
Control	.454	1.17	1.99	.05
Schiz. III	.323			
Schiz. I	.189	1.42	1.92	.05
Schiz. III	.323			
Schiz. II	.185	(N = 5 too small for tests)		

Table 2

Frequencies in Each Group Classified by Mean GSR CR/CR+UCR

	Above .45	Below .45
Controls	13	5
Schiz. I	1	11
Schiz. II	0	5
Schiz. III	4	8

Table 3

Variance in Latencies of GSR on First Two Trials of Each Tone for the Extinction Session.

Controls	Variance	F-test	Significance
1	.0524	229.01	.01
2	.6109	19.64	.01
3	.4875	24.62	.01
4	.1419	84.57	.01
5	.5925	20.25	.01
6	___ *	___	
7	.2283	52.56	.01
8	.6974	17.21	.01
9	.0987	121.58	.01
10	___	___	
11	.0741	161.94	.01
12	.3518	34.11	.01
13	.1120	13.89	.01
14	.0086	228.57	.01
15	___	___	
16	6.7085	1.79	N. S.
17	.0372	322.5	.01
18	.2623	45.7	.01

Table 3 (cont.)

Group I	Variance	F-test	Significance
1	—	—	
2	—	—	
3	21.4833	1.75	N. S.
4	.1419	84.57	.01
5	1.5182	7.905	N. S.
6	.9512	12.62	.01
7	—	—	
8	5.6871	2.11	N. S.
9	3.496	3.43	N. S.
10	—	—	
11	.0401	291.26	.01
12	—	—	

Group II	Variance	F-Test	Significance
1	—	—	
2	—	—	N. S.
3	—	—	
4	12.4605	1.04	N. S.
5	5.443	2.20	N. S.

Table 3 (cont.)

Group III	Variance	F-test	Significance
1	.0787	152.51	.01
2	.3549	33.81	.01
3	.2870	41.83	.01
4	.1759	68.22	.01
5	13.2535	.9054	N. S.
6	.6943	17.28	.01
7	—	—	
8	.5709	21.02	.01
9	16.9997	.7059	N. S.
10	—	—	
11	.2253	53.26	.01
12	.1049	114.39	.01

* Dash indicates 0, 1 or 2 responses which are too few on which to compute a variance.

Table 4

Frequencies in Each Group Classified by Both Mean GSR Amplitude CR/CR+UCR (.45) and Significant (P= .01) Variance in Latency for Extinction

	Above .45 Sig. σ_L^2	Below .45 Non Sig. σ_L^2
Controls	13	5
Schiz. I	1	11
Schiz. II	0	5
Schiz. III	3	9

Table 5

Variance in Latencies of GSR on the Selected Eight Trials in Conditioning Sessions One and Two

Controls	Variance	F-test	Significance
1	.6475	4.633	.05
2	.3975	7.547	.01
3	.2125	14.1176	.01
4	.2500	12.000	.01
5	.6050	4.9587	.05
6	.4025	7.4534	.01
7	.1175	25.31	.01
8	.1375	27.907	.01
9	.0250	120.00	.01
10	.1250	24.0000	.01
11	.2850	10.5263	.01
12	.2825	10.6195	.01
13	.3075	9.7561	.01
14	.1400	21.428	.01
15	.0425	70.5888	.01
16	.0925	32.4324	.01
17	.5200	7.4534	.05
18	.4325	6.9236	.01

Table 5 (cont.)

Group I	Variance	F-test	Significance
1	1.4325	2.0942	N. S.
2	—	—	
3	.0325	92.3077	.01
4	..1025	29.2683	.01
5	.5100	5.8823	.05
6	.0525	57.1429	.01
7	—	—	
8	1.2500	2.400	N. S.
9	1.1475	2.6144	N. S.
10	1.4975	2.0033	N. S.
11	.3125	9.600	.01
12	.2150	13.9535	N. S.

Group II	Variance	F-test	Significance
1	.0835	1.4371	N. S.
2	—	—	
3	—	—	
4	.0200	6.00	N. S.
5	2.0125	1.4907	N. S.

Table 5 (cont.)

Group III	Variance	F-test	Significance
1	.1225	24.5902	.01
2	.3775	7.9470	.01
3	.5075	5.9113	.05
4	.5000	6.000	.01
5	1.885	1.5915	N. S.
6	1.3300	2.2556	N. S.
7	.0325	92.3077	.01
8	.4125	7.2777	.05
9	.6450	4.6512	.05
10	—	—	
11	—	—	
12	.4900	6.1224	

Table 6

Base Levels and Responses of Four Pain Stimuli Following Extinction

	Intensity of Stimulus ma	CONTROLS Base	CONTROLS Response		SCHIZ. I Base	SCHIZ. I Response		SCHIZ. II Base	SCHIZ. II Response		SCHIZ. III Base	SCHIZ. III Response	
GSR (μmhos)	2.5	3.78	.58		5.34	2.10		3.28	1.29		4.94	1.04	
	3.5	3.74	.80		5.86	1.81		3.23	2.18		5.21	.84	
	4.0	3.62	1.26		6.18	2.07		3.40	2.28		5.20	1.02	
	4.5	3.74	1.40		6.27	2.38		4.20	2.22		5.12	1.04	
	ma	Base	Response Inc.	Response Dec.	Base	Response Inc.	Response Dec.	Base	Response Inc.	Response Dec.	Base	Response Inc.	Response Dec.
Skin Potential (mv)	2.5	-30.3	2.92	1.42	-21.2	1.80	2.82	-16.8	1.20	4.75	-14.5	1.40	3.46
	3.5	-29.1	1.42	2.72	-22.6	2.23	2.93	-20.4	1.25	9.3	-16.9	.97	1.62
	4.0	-29.7	2.14	5.35	-21.4	2.98	4.28	-18.8	.30	5.65	-16.0	1.54	2.09
	4.5	-28.8	1.93	6.04	-22.7	3.94	.97	-21.5	4.50	4.00	-13.2	1.00	3.70

Table 7

GSR CR to the Three Tones for First and Second Conditioning Combined

	T_o	T_1	T_2
Controls	.396	.522	.563
Schiz. I	.139	.140	.177
Schiz. II	.048	.041	.046
Schiz. III	.229	.237	.283

NASA-Langley, 1965 CR-156